

Hooke's Law states that the force required to deform a spring is proportional to the amount by which the spring deforms.

$$F = kx$$

If the deforming force is a hanging mass, $F = mg$

1. What force is required to deform a spring with a spring constant of 1250 N/m by 2.5 cm? [31 N]
2. A mass of 3.5 kg is hanging from a spring which deforms by 21.2 cm. What is the spring constant k ? [162 N/m]

The Energy stored in a spring is Elastic energy.

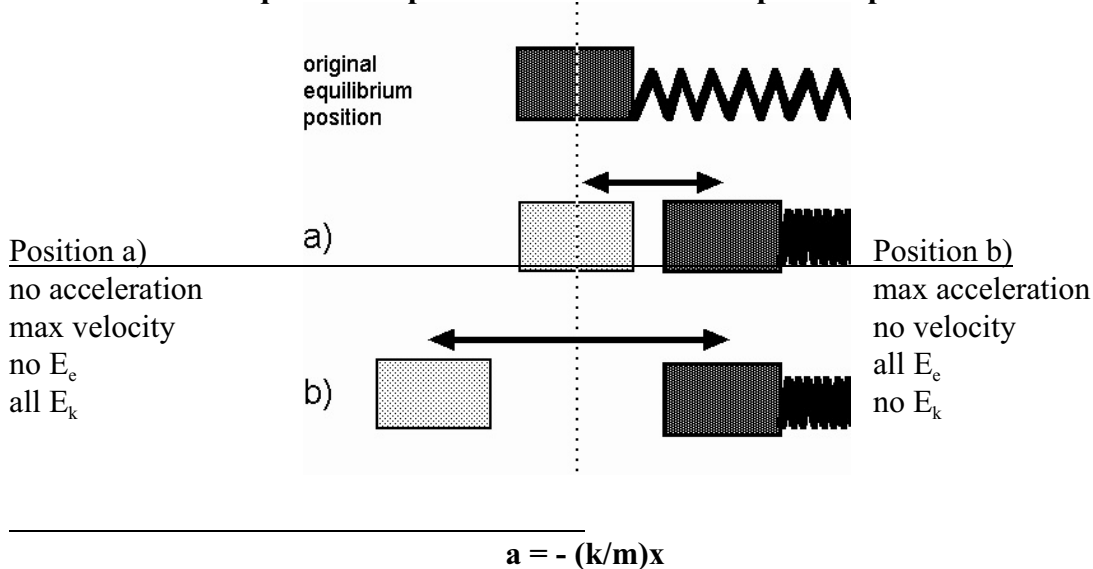
$$E_e = \frac{1}{2} kx^2$$

3. How much energy is stored in the spring from problem 1? [0.39 J]
4. By how much would you have to deflect a spring with $k = 768$ N/m in order to store 86 J of energy? [0.47 m]

The Energy stored in a spring can be transformed into various other kinds.

5. A 2.5 kg mass is released from a height of 1.7 m onto a spring with $k = 845$ N/m. By how much will the spring deflect? [0.31 m]
6. A 4.0 kg mass is held against a spring with a spring constant of 420 N/m and deflected by 12.0 cm. The block is then released.
 - a) What is the kinetic energy of the block when it is just released? [3.0 J]
 - b) How fast is it going when it is just released? [1.2 m/s]
 - c) If the block hits a rough patch $\mu_k = 0.456$ how far will it go before it stops? [0.17 m]
7. A 25.0 kg mass is moving at 1.5 m/s when it contacts a spring and deflects it by 34 cm. What is the spring constant k of the spring? [487 N/m]

Simple Harmonic Motion (SHM) is the repeated motion of a mass-spring system about an equilibrium point. There are some important points to note.



8. A 2.3 kg mass-spring system is oscillating in simple harmonic motion. If the spring has a spring constant of 12000 N/m and a max deformation of 16.2 cm, calculate:

- max acceleration [845 m/s²]
- acceleration at the equilibrium position [0 m/s²]

Recall that the total Energy of a mass spring system is a combination of kinetic and elastic energy

$$E_T = E_K + E_e$$

9. A 4.0 kg mass is undergoing SHM on a horizontal spring with $k = 1500$ N/m. The mass is deflected 0.15 m and released.
- What is the max acceleration of the spring? [56 m/s²]
 - What is the total energy of this system? [16.9 J]
 - What is the acceleration of the system when $x = 0.08$ m? [30 m/s²]
 - What is the velocity of the mass when $x = 0.08$ m? [2.5 m/s]
 - How fast is the mass going as it passes the equilibrium point? [2.9 m/s]
10. A 6.0 kg mass is hung from a spring on a tree and the spring deflects by 0.175 m. The spring is then removed and attached to a 1.4 kg mass. This mass is pulled 25 cm horizontally and released.
- What is the max acceleration of the mass? [-60 m/s²]
 - How fast is the mass going when the deflection is only 18 cm? [2.69 m/s]